KALAUAO STREAM BRIDGE **HAER No. HI-117**
(Kalauao Stream Eastbound Bridge & Kalauao Stream Westbound Bridge)
Kamehameha Highway and Kalauao Stream
Aiea
Honolulu County
Hawaii

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
U.S. Department of the Interior
National Park Service
Oakland, California

HISTORIC AMERICAN ENGINEERING RECORD

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David Franzen, Photographer May 2012

HI-117-1 OVERVIEW SHOWING APPROACH TO WESTBOUND BRIDGE. VIEW FACING WEST.

HI-117-2 OVERVIEW WITH WESTBOUND BRIDGE ON THE RIGHT AND EASTBOUND BRIDGE ON THE LEFT. VIEW FACING NORTH-NORTHWEST.

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HI-117-6 DETAIL OF A 1966 PARAPET AND STANCHION WITH SCALE DEVICE [ONE-FOOT INCREMENTS]. VIEW FACING SOUTHWEST.

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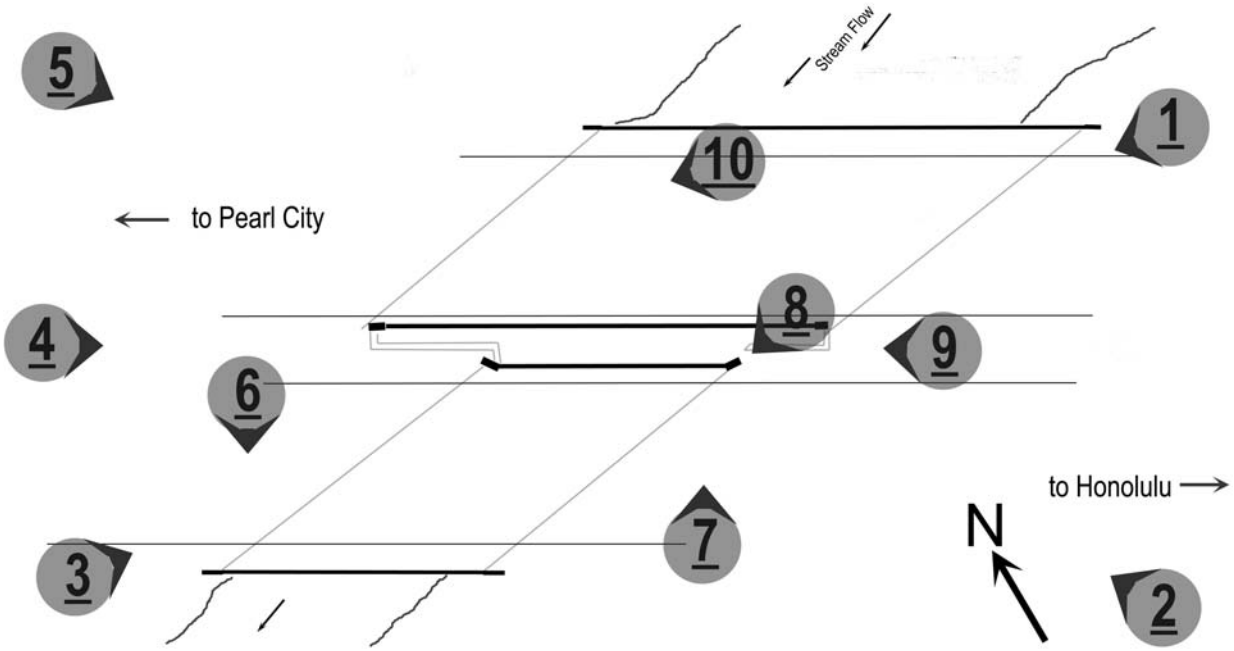
HI-117-10 UNDERSIDE OF WESTBOUND BRIDGE, SHOWING THE LAVA ROCK AND CONCRETE MASONRY ABUTMENT. NOTE THE RETAINING WALL AT LEFT BACKGOUND THAT NARROWS THE STREAM CHANNEL UNDER THE EASTBOUND BRIDGE. VIEW FACING WEST.

HI-117-11 KALAUAO STREAM BRIDGE DRAWING DATED JUNE 1945. *State of Hawaii, Department of Transportation, Highways Division, Design Branch, Project No. DA-WR 10 (3), drawing 5157.6.*

PHOTO KEY



HISTORIC AMERICAN ENGINEERING RECORD

KALAUAO STREAM BRIDGE
(Kalauao Stream Eastbound Bridge & Kalauao Stream Westbound Bridge)

HAER No. HI-117

Location: Kamehameha Highway and Kalauao Stream
Aiea
City and County of Honolulu, Hawaii
U.S.G.S. Topographic map, Waipahu Quadrangle 1998 (7.5 minute series) Universal Transverse Mercator Coordinates NAD 83: 04.609850.2364650

Present Owner: State of Hawaii

Present Use: Vehicular Bridge

Significance: The Kalauao Stream Bridge is a significant resource in the history of Oahu's road transportation system. It is significant at the local level for its association with the development of this section of Kamehameha Highway, and the adjacent Aiea and Pearl City settlements, which grew into suburbs from their initial establishment as a sugarcane plantation and a train-stop "city," respectively.

Historian: Dee Ruzicka
Mason Architects, Inc.
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Honolulu, HI 96813

Project Information: This report is part of the documentation for properties identified as adversely affected by the Honolulu Rail Transit Project (HRTP) in the City and County of Honolulu. This documentation was required under Stipulation V.C. (1, 2) of the Honolulu High-Capacity Transit Corridor Project (HHCTCP) Programmatic Agreement (PA), which was signed by the U.S. Department of Transportation's Federal Transit Administration, the Hawaii State Historic Preservation Officer, the United States Navy, and the Advisory Council on Historic Preservation. After consultation with the City and County of Honolulu, the National Park Service, Pacific West Regional Office, in a letter dated June 29, 2011, stipulated the details of the required documentation efforts, including HAER documentation for this and other bridges affected by the HRTP. Archival photographs were taken by David Franzen, Franzen Photography, Kailua, HI. The field work was conducted in May 2012, and the report was prepared in June 2012. The report was finalized in December 2012.

Part I. Historical Information:

A. Physical History:

1. **Date of construction**: 1936, 1945, 1966
2. **Engineer**: 1936, unknown. 1945, William R. Bartels. 1966, C.R.Y. / R.K.

   1936. No plans were located.

   1945. William R. Bartels, bridge engineer for the Hawaii Territorial Highway Department. He received his education and training in Germany and immigrated to Hawaii in 1932 when he commenced working with the Highway Department; he continued his career there until his retirement in 1958.[1] During that period he was a prolific and versatile designer, responsible for large and sophisticated bridge construction projects in Hawaii, including many tee-beam and rigid-frame concrete bridges. He also designed the reinforced-concrete girder bridges (Waimalu Bridge and Kalauao Springs Bridge) and this steel I-beam bridge along the Aiea-Waimalu segment of Kamehameha Highway. Bartels' name appears on original drawings of the 1945 Waimalu Bridge as the designer. These drawings were completed in June 1945, drawn by Paul Yamashita but designed and checked by Bartels. B. F. Rush, the Territorial Highway Engineer in 1945, approved the drawings.[2]

   1966. C.R.Y. & R.K. are the initials appearing after the note "designed by" in the margins of drawings for the 1966 widening of Kamehameha Highway that added an extra lane to both the 1936 and the 1945 bridges. These drawings are dated June 1965.[3]
3. **Builder**: 1936 - Walker & Olund, Ltd.[4] 1945 – E. E. Black, Ltd.[5]
4. **Original plans and construction**: The Kalauao Stream Bridge is comprised of two bridges that both cross over Kalauao Stream, each of which carries three lanes of traffic in opposite directions, eastward and westward. The original bridge, built in 1936, had two lanes, with one for each direction. This bridge, since 1945, carries the eastbound traffic. It retains a concrete parapet with cross-shaped voids and curved concrete end stanchions. Those two original end stanchions have stepped corner detailing, along with year built (1936) and bridge name inscriptions.

   In 1945, the original bridge was augmented by the construction of a second two-lane bridge beside it, *mauka* (common Hawaiian term denoting: inland) of the 1936 one. After this construction, each bridge carried two lanes of traffic in opposite directions. The 1945 bridge conveys the westbound traffic. It retains concrete parapets with cross-shaped voids and rectangular end stanchions. Although not curved like the 1936 end stanchions, the remaining 1945 stanchions on the second bridge have similar stepped corner detailing, as well as year built (1945) and bridge name inscriptions.

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[1] "TH Honors 4 Veteran Employees," *Honolulu Advertiser*, July 1, 1958, article at the University of Hawaii, Hamilton Library, Honolulu Newspapers Clippings Morgue, on microfiche in Biographical section under: Bartels.
[2] State of Hawaii, Department of Transportation, Highways Division, Design Branch, Project No. DA-WR 10 (3), Plans of Three Bridges on Kamehameha Highway, Drawing 5157.1. June 18, 1945.
[3] State of Hawaii, Department of Transportation, Highways Division, Design Branch, FAP No. U-090-I (9), Kalauao Stream Bridge Widening, Drawing 58. June 1965.
[4] "Aiea Highway Link Dedicated," *Honolulu Star Bulletin,* August 25, 1937. p. 6.
[5] Superintendent of Public Works, *Report to the Governor, Territory of Hawaii, for the Year Ending June 30, 1946* [Honolulu: author] [1946]. p. 26.

In 1966, the State of Hawaii, Department of Transportation widened both the 1936 and 1945 bridges with a third lane in each direction. The new lanes, replacement walkways, and new parapets required demolition of the outboard walkways and parapets of each bridge. The 1966 parapet design features a concrete lower section, topped with two horizontal cylindrical metal rails. The concrete end stanchions are simple rectangular forms with year built (1966) and bridge name inscriptions.

The *makai* (common Hawaiian term denoting: toward the sea) eastbound bridge retains its original *mauka* parapet and end stanchions, dating from 1936. The *mauka* westbound bridge retains its original *makai* parapet and end stanchions, dating from 1945. These older parapets are adjacent to each other, on the inboard side of both bridges.

Both the eastbound bridge and the westbound bridge are listed as "stringer/multi-beam or girder" designs, with prestressed concrete, in the National Bridge Inventory (NBI) Database.[6] However, only the 1966 portion of those bridges used prestressed concrete in the structural design. The 1936 original bridge (now two lanes of the eastbound bridge) was a girder design with cast-in-place concrete. The 1945 bridge (now two lanes of the westbound bridge) was listed as "steel I-beam span" type in a 1950 survey.[7]

5. **Alterations and additions**: The bridges have added steel guardrails at their approaches. They are attached to the stanchions on the western approach to the eastbound bridge and to both 1945 stanchions of the westbound bridge. The 1966 drawings for the Kamehameha Highway widening project do not show these guardrails, so they must have been additions after 1966.

B. Historical Context:

There are two other related bridges along this stretch of Kamehameha Highway, built under the same series of project numbers -- see the Historic American Engineering Record (HAER) reports for Waimalu Bridge (HAER No. HI-115) and Kalauao Springs Bridge (HAER No. HI-116). The original Waimalu Bridge, Kalauao Springs Bridge, and Kalauao Stream Bridge were all initially constructed in 1936-1937; Waimalu Bridge was part of Federal Aid Project (FAP) No. 9-F and the Kalauao Springs and Stream bridges were part of National Recovery Highway (NRH) Project No. NRH-9-C.[8] In 1945, under Hawaii Project No. DA-WR 10 (3), three additional two-lane bridges were built parallel to the original ones, and these new bridges all carried the westbound lanes. The 1966 Kamehameha Highway widening, FAP No. U-090-I (9), included an additional lane on the outboard sides of all six bridges.

The Waimalu Bridge report (HAER No. HI-115) contains general information on the reinforced-concrete girder bridge type. Moreover, it has contextual history on the Honolulu Plantation Company (HPC), which had its mill and main plantation housing areas in Aiea, along with information about the Kalauao Springs, which were the main sources of water for HPC. This report does not repeat that information.

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[6] National Bridge Inventory Database, Kalauao Stream Bridge, on website nationalbridges.com, accessed May 23, 2012. The eastbound bridge has NBI Structure Number 003000990402074, and the westbound bridge has NBI Structure Number 003000990402075.

[7] Territorial Highway Department, Hawaii Highway Planning Survey, Bridge Inventory for the Island of Oahu (Prepared in Cooperation with the U.S. Department of Commerce, Bureau of Public Roads) September 1950. pp. for Bridge 8.

[8] Superintendent of Public Works, *Report to the Governor, Territory of Hawaii, for the Year Ending June 30, 1936* (Honolulu: New Freedom Press) [1936]. pp. 10 & 11.

Kamehameha Highway

Until 1936 Kamehameha Highway was the only road that provided passage across the *ahupuaa* (common Hawaiian term for land divisions that typically extend from the mountains to the sea) of Kalauao, Waimalu, Waiau, and Waimano, between the settlements at Aiea and Pearl City. The pre-1936 alignment of this highway ran east-west along a winding route located on firmer ground, but not as level as the well-watered soils closer to Pearl Harbor. Part of Kamehameha Highway's pre-1936 route between Aiea and Pearl City is the present-day alignment of Moanalua Road. Today's section of Moanalua Road between Kaonohi Street and Moanalua Loop is a new straighter alignment; the pre-1936 Kamehameha Highway route followed what are now Kaonohi Street and Moanalua Loop.

Planning for the realignment of Kamehameha Highway, in this area that included the 1936 Kalauao Stream Bridge, had started before 1933, when NRH funds became available; that year road improvements from Honolulu to Pearl City Junction were on the list for the grants. Within that planned project, the highway section from Honolulu to Aiea had a higher priority, and the remaining section, from Aiea to Pearl City Junction, was to be undertaken "if financially possible."[9] Two years later, this section beyond Aiea still awaited funding. In 1935, Louis S. Cain, Superintendent of Public Works, submitted a road plan to the U.S. Bureau of Public Roads that included the construction of an "additional unit of Kamehameha Highway beyond Aiea, approximately one mile" that was expected to cost $148,000.[10] The contract amount reported in March 1937 for construction of the highway from "Aiea through Pearl City" was $203,000.[11]

On August 24, 1937, the new alignment of Kamehameha Highway between Aiea and Pearl City was dedicated. This new road passed over the three 1936 bridges, crossing Waimalu Stream, Kalauao Springs, and Kalauao Stream. The two lanes of the 1937 Kamehameha Highway are the present-day two inner lanes of the eastbound half of the highway. The construction firm of Walker & Olund built the section of this 1937 road, between about Kaonohi Street and Aiea, including the Kalauao Stream Bridge.[12] See below for further information about that firm and the funding for the 1936-1937 Aiea-to-Pearl City highway construction.

In 1945 Kamehameha Highway between Aiea and Pearl City was improved by the addition of another two traffic lanes, separated by a median from the 1937 two-lane highway. This allowed the 1945 lanes to be dedicated to westbound traffic and the 1937 lanes to carry eastbound vehicles. This improvement included the 1945 portion of the Kalauao Stream Bridge, which was originally built with matching parapets and stanchions on each side of the new roadway. This 1945 construction was carried out under Hawaii Project No. DA-WR 10 (3).[13] According to the Superintendent of Public Works report after World War II:

> During the war years, highway construction activities were limited to the building of new highways, which served as access to military and navy reservations and to those highways, which are part of the strategic network….

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[9] "Hawaii Road Building Projects Selected," *Honolulu Star Bulletin*, June 24, 1933. p. 1.
[10] "Cain Submits Road Plan to U.S. Officials," *Honolulu Star Bulletin*, May 3, 1935. p. 1.
[11] "Cain Reveals Road Scheme for 5 Islands," *Honolulu Star Bulletin*, March 6, 1937. p. 1.
[12] "Aiea Highway Link Dedicated," *Honolulu Star Bulletin*, August 25, 1937. p. 6.
[13] State of Hawaii, Department of Transportation, Highways Division, Design Branch, Project No. DA-WR 10 (3), Plans of Three Bridges on Kamehameha Highway, Drawing 5157.1. June 18, 1945. .

> As most military and navy reservations are adjacent to and are served by the main public highways, large sums of Federal access money were spent on the latter with the result that all traffic has benefited by these improvements.[14]

The term "access money" was explained in the Superintendent of Public Works 1945 report, as 100% Federal funding for military access roads and "those highways which are part of the strategic network."[15] At the end of the war in August 1945, "all proposed access road projects were dropped by the Federal Government …; but access road projects under construction were allowed to continue to their completion."[16] This widened part of Kamehameha Highway improved access between the main part of the Pearl Harbor Naval Base and its outlying activities near Pearl City Peninsula, Waipio Peninsula, and further west.

E .E. Black, Ltd., a well-known Hawaii contracting firm, obtained two separate construction contracts in 1945 for the highway improvements near Aiea (between Pearl Harbor installation and outlying Navy activities to the west). The amount of the contract for the two new Kamehameha Highway westbound lanes was $381,177.40; and their accepted bid for three new bridges (the 1945 Waimalu, Kalauao Springs, and Kalauao Stream bridges) along this corridor was $139,207.50.[17]

In 1966, the State of Hawaii, Department of Transportation carried out another improvement to this segment of Kamehameha Highway, adding a third lane to both existing two-lane roadways, under FAP No. U-090-I (9). This widening project was in response to numerous complaints about "bumper-to-bumper Kamehameha Highway rush hour traffic past Pearl Harbor," with protests reported at least as early as 1964.[18] The third lane was added on the outer edge (opposite the median) of each roadway. This resulted in the demolition of the outer parapets, stanchions, and walkways of the 1936 and 1945 bridges and the construction of the extant 1966 replacements of these elements on the outer edges of the new traffic lanes.[19]

Kamehameha Highway in this section, while also important to the military, has always linked the Aiea and Pearl City communities. See the history of Aiea in the report on Waimalu Bridge (HAER No. HI-115) and of Pearl City in the report on Waiawa Bridge (HAER No. HI-101).

Original Kamehameha Highway Funding around Kalauao and Construction Difficulties

The contract from the Territorial Department of Public Works, for the section of Kamehameha Highway that included the Kalauao Springs and Kalauao Stream Bridges, was awarded for $153,647.87, with most of the cost covered by the federal government, as "U.S. Public Works Project No. NRH-9-C."[20] This type of funding was basically a grant and did not require matching Territorial money. Due to the Great Depression in the 1930s:

> In June 1933, Congress passed the National Industrial Recovery Act (NIRA). The act was designed to help individual states with a variety of programs including new highway construction…. It was also designed to aid the states in

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[14] Superintendent of Public Works, *Report to the Governor, Territory of Hawaii, for the Year Ending June 30, 1946* [Honolulu: author] [1946]. p. 17.
[15] Ibid., [1945]. p 13.
[16] Ibid., [1946]. p. 17
[17] Ibid., [1946]. p. 26.
[18] "Pearl City Traffic Saddens Police, Too," *Honolulu Star Bulletin*, June 22, 1964. p. 3.
[19] State of Hawaii, Department of Transportation, Highways Division, Design Branch, FAP No. U-090-I (9). As Built Plans of Kamehameha Highway Widening, Drawings 1-6 & 58-87. July 22, 1965.
[20] Superintendent of Public Works, *Report to the Governor, Territory of Hawaii, for the Year Ending June 30, 1936* (Honolulu: New Freedom Press) [1936]. p. 10.

> providing unemployment relief for the millions out of work. Under the NIRA of 1933, individual states were able to obtain additional funds through grant programs, such as the National Recovery Highway… program, [under which] the United States Bureau of Public Roads stipulated that portions of the funding should be used for roadside landscaping and to develop shore routes and inland tourist lanes.[21]

This section of Kamehameha Highway did run near part of Pearl Harbor's shoreline, but it certainly was not designed as a tourist route. Rather it was noted that upon its "completion the public will have available an improved highway from Honolulu to the fast growing community of Wahiawa."[22] This was not an easy area for highway construction, due to numerous wetlands in the *ahupuaa* of Kalauao, Waimalu, Waiau, and Waimano. The names of all of those *ahupuaa* contain the word *"wai"* (Hawaiian term for water), except for Kalauao, which means "the multitude [of] clouds."[23] These *ahupuaa,* between the settlements at Aiea and Pearl City, and were noted for their extensive irrigated fields in the eighteenth through the early twentieth centuries. Such wetlands were one reason that the original alignment of Kamehameha Highway had been inland, on more topographically varied, but more solid ground.

A newspaper article at the 1937 opening of the "Aiea Highway," as this portion of Kamehameha Highway was called, noted that for the contractors:

> A difficult engineering problem was faced in building a durable road bed since the highway skirts Pearl Harbor and in many places passes through former swamp lands…. In constructing the highway, it was necessary to lay a lumber mat of 265,000 board feet before putting in the rock sub-base. [24]

Although part of "Aiea Highway" officially opened for traffic on August 24, 1937, there was a mile-long portion where it was "still necessary to detour through Aiea to the old Kamehameha Highway."[25] Despite the ceremonies "marking an important step in territorial highway development," the roadway surface was, at that date, only loose rocks treated with oil, with a plan that "a macadam finish will be applied within one year."[26]

Walker & Olund, Ltd.

The contracting company that built the Kalauao Springs Bridge and Kalauao Stream Bridge in 1936-1937, along with several miles of connecting highway segments, was the firm of Walker & Olund, Ltd. John Walker, born in Scotland, came to Hawaii about 1884. Around 1900 he founded his own company, under the name John Walker, Contractor, and the firm has continued to this day, currently under the name Walker-Moody Construction Company, Ltd. Alfred E. Olund, who was born in Minnesota and arrived in Hawaii by 1912, started working with Mr. Walker in 1920. In 1924, the firm was called Walker & Olund, Ltd., and it continued until 1940 with that name, despite the 1928 death of John Walker. The business did not get

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[21] Irene Jackson Henry and William Henry, Historic American Engineering Record, Veterans Memorial Park and Parkway, Muskegon, Michigan (Eagle, Michigan: Henry & Henry Preservation and Architectural Consultants). July 1996, on website lcweb2.loc.gov/pnp/habshaer/mi/mi0400/mi0455/, accessed June 13, 2012.

[22] Superintendent of Public Works, *Report to the Governor, Territory of Hawaii, for the Year Ending June 30, 1937* (Honolulu: Porter Printing Company, Ltd.) [1937]. p. 22.

[23] Mary Kawena Pukui, Samuel E. Elbert, & Esther T. Mookini, *Place Names of Hawaii* (Honolulu: University of Hawaii Press) 1976. p. 75.

[24] "Aiea Highway Link Dedicated," *Honolulu Star Bulletin*, August 25, 1937. p. 6.

[25] "New Aiea Road Open August 20," *Honolulu Star Bulletin*, August 3, 1937. p. 5.

[26] "Aiea Highway Link Dedicated," *Honolulu Star Bulletin*, August 25, 1937. p. 6.

renamed Walker-Moody Construction Company, Ltd. until 1941, although Mr. Olund had left the firm and Mr. Moody had joined it in 1939. Today, Walker-Moody Construction Company's website states that Walker's company "was one of Hawaii's largest and most respected construction firms."[27] Some of the landmark projects that the company completed in its early decades were the Sacred Heart Catholic Church, "the territorial office building, the new Honolulu city hall, Pier 11, the Territorial hospital for the insane at Kaneohe, the concrete work for the great oil tanks at Pearl Harbor naval base, and the magnificent new home of C. Brewer & Co., Ltd."[28]

Steel I-Beam Bridges

Steel I-beam bridges use rolled steel beams as longitudinal members (stringers). Rolled steel beams came into general use for highway bridges in the 1920s and 1930s, as steel plants gained the ability to form steel beams into the greater lengths and depths required by bridge designers. By the early 1960s, the use of steel I-beams for bridge structures became less common due to rising steel prices and the decreasing costs of prestressed concrete beams.[29]

Part II. Structural/ Design Information:

A. General Statement:

1. **Character**: The Kalauao Stream Bridge retains original parapets, stanchions, and its original structural design. The eastbound bridge has a 1936 parapet, end stanchions, and structure that are typical of reinforced-concrete bridges constructed in Hawaii in the latter half of the 1930s. The westbound bridge has a 1945 parapet and end stanchions typical of reinforced-concrete bridges constructed in Hawaii during the 1940s. Both have a parapet design featuring cross-shaped voids. The 1936 curved end stanchions are typical of bridges up to that date, and the rectangular stanchions of the 1945 portion are typical of bridges built in the 1940s. The eastbound bridge is approximately 54' in length, with a single span, while the westbound bridge has two spans and a total length of about 96'. The 1966 additions to the bridges are quite different in the design of their structure, parapets, and stanchions. This contrast, however, conveys the history of the area and its rapid post-statehood growth. The 1966 sections of the bridges are not considered detracting features.
2. **Condition of Fabric**: Good. The overall integrity of the property remains high, except for the setting, which has changed from rural to urban. The guardrail additions are minor alterations.

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[27] Walker-Moody Construction Company, Ltd., "The Walker Moody Story – Company History, Start – 1940," On website at http://www.walker-moody.com/inde.php/company-history-start-1940.html, accessed on June 13, 2012.
[28] Ibid. (in Olund biography section).
[29] Parsons Brinckerhoff and Engineering and Industrial Heritage, A Context for Historic Bridge Types, NCHRP Project 25-25, Task 15 (Prepared for the National Cooperative Highway Research Program) October 2005. p. 3-107.

B. Description:

Both three-lane bridges carry Kamehameha Highway across Kalauao Stream. The original (1936) two lanes of the *makai* eastbound bridge are reinforced-concrete girder construction[30] with a single span of about 54'. The original (1945) two lanes of the *mauka* westbound bridge are steel I-beam stringer construction with two spans, each of about 48'. The structure under the 1966 portion of each bridge uses prestressed girders.[31] Both the eastbound bridge and westbound bridge have a roadway approximately 40' wide. Each bridge has one or two concrete walkways approximately 4' wide, which are about 4" higher than the roadway surface. The eastbound bridge has walkways along both its *mauka* (1936) parapet and along its *makai* (1966) edge, while the westbound bridge has a walkway only along its *mauka* (1966) parapet. The walkway along the 1936 parapet is now in the highway median and utilized by few pedestrians.

The inner parapet on each bridge is comprised of the original parapet and stanchions, from either 1936 (on the eastbound bridge) or 1945 (on the westbound bridge). This original (1936 & 1945) construction on each bridge includes the structure supporting the two traffic lanes adjacent to the original parapets. The 1966 widening increased the width of each bridge from two to three traffic lanes and built replacement walkways along the new parapets.

Eastbound Bridge (1936/1966)

The eastbound bridge has three traffic lanes on an asphalt-surfaced roadway. The 1936 concrete parapet and stanchions are on the *mauka* side of this bridge. This parapet is 2'-10" high and about 50' long. The parapet has a top railing 1'-0" wide and 7" high with 1½" stepped corners. Below the railing is a series of vertical concrete balusters (6" wide and 6" thick) that are typically spaced at 1'-7" on center. The sections of each parapet that are between the balusters are slightly thinner (4" thick) and each section was formed with a cross-shaped void. These voids are typical of concrete bridge design in Hawaii during the 1930s and 1940s and are commonly referred to as a Greek-cross shape.[32] Each cross void is 1'-3" high and 8" wide. The base of each parapet is 7" high and 10" thick along its full length. On the inboard side of the parapet is a walkway, 3'-0" wide and about 4" higher than the road pavement. The height differential results in an approximately 4"-high concrete curb along the road.

The 1936 concrete end stanchions are 3’-3" high (measured from the roadway), 1'-9" thick, and about 4' long. In plan, each forms the arc of a circle spanning about 30 degrees. The stanchion end squarely abuts the parapet and the stanchion arcs away from the roadway, presenting a curving face to the traffic lanes. Each stanchion has 1½" stepped corners, with a top surface that is 1'-3" wide. The west stanchion has an added wedge of concrete on its outer (road-facing) surface that anchors a steel W-beam guardrail, which extends along the roadway at the approach. Typically, concrete bridges of this type and period have year built and bridge name inscriptions on their end stanchions. However, the added concrete wedge covers the name

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[30] Reinforced-concrete girder bridges have a monolithic deck and girder design of cast-in-place concrete, and replaced earlier concrete arch bridges for short spans. This type of bridge does not have the load-carrying capacity of tee-beam bridges and was used in Hawaii up until the 1930s, as an economical choice for short spans.

[31] State of Hawaii, Department of Transportation, Highways Division, Design Branch, FAP No. U-090-I (9), Kalauao Stream Bridge Widening, Drawing 58. June 1965.

[32] Heritage Center, School of Architecture, University of Hawaii at Manoa, State of Hawaii, Historic Bridge Inventory and Evaluation, (Prepared for the State of Hawaii, Department of Transportation, Highways Division) 2008. p. I-30.

inscription on this stanchion. The east end stanchion has the date inscription "1936" in 3"- high block numbers.

The 1966 parapet and end stanchions of the eastbound bridge are on the *makai* side. The lower part of the 1966 parapet is concrete, 1'-2" thick and 1'-6" high. There is a horizontal line incised across it, at the height of 9". The upper section of the 1966 parapet is a metal railing composed of two horizontal cylinders supported by slightly curved rail posts. The bottom rail is 5" in diameter and the top rail is 3" in diameter. The posts are spaced about 7' apart along the length of the parapet. The posts are bolted to the top surface of the lower concrete. The 1966 end stanchions are rectangular concrete, 1'-2" thick, 3'-1" high, and 5'-0" long. Each has 1"-wide horizontal lines incised around its circumference, at heights of 9" and 1'-6" above the walkway. The west stanchion has the inscription "Kalauao Springs Bridge 1966" in 3" high block lettering.

The underside of the eastbound bridge shows the structural design of both the original 1936 bridge and the added 1966 traffic lane and walkway. The 1936 portion carries the two *mauka* lanes. It is board-formed concrete with five longitudinal concrete beams about 3'-6" high and 1'-6" wide. The outer lane and walkway, dating from 1966, are supported by two prestressed concrete girders. The bridge has concrete abutments, which the 1965 drawings show are supported by piles.[33]

Westbound Bridge (1945/1966)

This westbound bridge has three traffic lanes on an asphalt-surfaced roadway. The 1945 concrete parapet and stanchions are on the *makai* side of this bridge. The parapet of this bridge is almost identical to the 1936 parapet described above, with a few differences. This 1945 parapet is much longer, over 100' in length; and, instead of having a walkway extending along its length, it has a 6"-high, 10"-wide concrete curb. Another contrast is the 1945 concrete end stanchions are rectangular, not curved.

The 1945 rectangular stanchions measure 3'-3" high, 1'-9" thick, and 3'-6" long. Each end stanchion has 1½" stepped corners and squarely abuts the parapet. Both end stanchions have an added W-beam guardrail, each guardrail through-bolted to one stanchion. These guardrails obscure the name (Kalauao Stream) and year built (1945) inscriptions on the stanchions. A 3"-diameter, red bull's-eye reflector is set into the traffic-facing (east) end of the east stanchion; the white paint on it and the guardrail render it non-functional.

The 1966 parapet on the westbound bridge is about 107' long. The parapet and end stanchions of this part of the westbound bridge are typical construction, as described above for the 1966 parapet of the eastbound bridge.

Under the reinforced-concrete deck of the westbound bridge, the 1945 section has six longitudinal girders (stringers) that are steel I-beams; each is about 3' high with a flange width about 1', and spaced at 7'-0" on center. The westbound bridge has two spans of about 50' each. The longitudinal I-beam stringers are supported at mid-point by 17 square-cross-section concrete piles topped by a 3'-0" tall concrete beam. The 1966 section of this bridge has a different structure, with two longitudinal girders of prestressed concrete that are 3'-9" high. Their mid-span support is a 3'-0" high concrete beam topping four octagonal-cross-section concrete piles.

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[33] State of Hawaii, Department of Transportation, Highways Division, Design Branch, FAP No. U-090-I (9), Kalauao Stream Bridge Widening, Drawing 58. June 1965.

The east abutment of the westbound bridge is board-formed concrete, and the west abutment is lava rock and concrete mortar masonry. At the downstream side of this bridge, the stream channel narrows from the approximately 96' width under the westbound bridge to the approximately 54' width under the eastbound bridge; this narrowing is done by means of concrete retaining walls that extend into the stream channel from the bridge abutments. These vertical retaining walls are 1'-6" thick and extend into the stream channel about 20' on the east side and about 26' on the west side, in an orientation approximately parallel to the roadway.

C. Site Information:

The Kalauao Stream Bridge is located along a mixed urban/residential section of Kamehameha Highway. In Hawaii roads are not given Tax Map Key (TMK) designations. This bridge lies just south of TMK 9-8-025: 060, which is a channelized portion of Kalauao Stream. *Mauka* of the highway, on both sides of the stream, are a few residences. To the northwest, beyond the residences, is a mid-rise office building, occupied by American Savings Bank, and the expansive Pearl Ridge Shopping Center. That shopping center was initially built circa 1969, with additional phases of development in following years. *Makai* of the highway, there are residences on the southeast side of the stream, and a low-rise strip mall on the southwest side. Approximately one-half mile to the east, is the well-developed community of Aiea. Historic aerial photos show that the setting around the bridge has changed greatly since its original 1936 construction date. Before World War II, the area was rural, and sugarcane fields were prevalent in the area. Aiea historically had a mill, along with residential and commercial buildings. Post-World War II development of housing and businesses along this corridor was accommodated or spurred by the addition of the 1945 bridges, and by the 1966 widening of all six bridges in this segment of Kamehameha Highway.

Part III. Sources of Information:

A. Primary Sources:

Architectural Drawings and Early Views

No original (1936) drawings or early photographs of the bridge were located for this report.

The 1945 and 1966 construction drawings are electronic files (scans) located in the database at the State of Hawaii, Department of Transportation, Highways Division, Design Branch:

1945 – Hawaii Project No. DA-WR 10 (3), dated June 18, 1945.
1966 – FAP No. U-090-I (9), dated July 22, 1965.

Drawings of the Kalauao Stream Bridge in this database were created by the Territorial or State Department of Transportation and are considered in the public domain.

Historic maps and aerial photos are located in the collection of the Hawaii State Archives. The maps were created and published by the U.S. Geological Survey and are public domain materials. Aerial photos used in this report were created for or collected by the Hawaii Territorial/ State Land Use Bureau and are unrestricted public records.

B. Secondary Sources:

Beechert, Edward D. *Working in Hawaii, A Labor History*. Honolulu: University of Hawaii Press. 1985.

Dorrance, William H. and Francis S. Morgan. *Sugar Islands, The 165-year Story of Sugar in Hawaii.* Honolulu: Mutual Publishing, LLC. 2000.

Henry, Irene Jackson and William Henry. Historic American Engineering Record, Veterans Memorial Park and Parkway, Muskegon, Michigan. Eagle, Michigan: Henry & Henry Preservation and Architectural Consultants. July 1996, on website lcweb2.loc.gov/pnp/habshaer/mi/mi0400/mi0455/, accessed June 13, 2012.

Heritage Center, School of Architecture, University of Hawaii at Manoa. State of Hawaii, Historic Bridge Inventory and Evaluation. Draft prepared for the State of Hawaii Department of Transportation, Highways Division. May 2008.

Honolulu Star Bulletin

"Hawaii Road Building Projects Selected; Work to Start July 1." June 24, 1933. p. 1.

"Allotment to Hawaii Roads is Agreed On." August 3, 1933. p. 1.

"$2,631,000 To Be Spent For Island Roads." August 16, 1933. p. 1.

"Moses Akiona is Low Bidder on Puuloa Road." November 10, 1933. p. 1.

"Cain Submits Road Plan to U.S. Officials." May 3, 1935. p. 1.

"Cain Reveals Road Scheme for 5 Islands." March 6, 1937. p. 1.

"New Aiea Road Open August 20." August 3, 1937. p. 5.

"Ceremony Will Open New Road." August 23, 1937. p. 7.

"Aiea Highway Link Dedicated." August 25, 1937. p. 6.

National Bridge Inventory Database. Kalauao Stream Bridge, on website nationalbridges.com, accessed May 23, 2012.

Parsons Brinckerhoff and Engineering and Industrial Heritage. A Context for Historic Bridge Types, NCHRP Project 25-25, Task 15. Prepared for the National Cooperative Highway Research Program. October 2005.

Pukui, Mary Kawena, Samuel E. Elbert, & Esther T. Mookini. *Place Names of Hawaii.* Honolulu: University of Hawaii Press. 1976.

Superintendent of Public Works. *Report to the Governor, Territory of Hawaii, for the Year Ending June 30.* Honolulu: Various Publishers. Various Years.

Territorial Highway Department, Hawaii Highway Planning Survey. Bridge Inventory for the Island of Oahu. Prepared in Cooperation with the U.S. Department of Commerce, Bureau of Public Roads. September 1950.

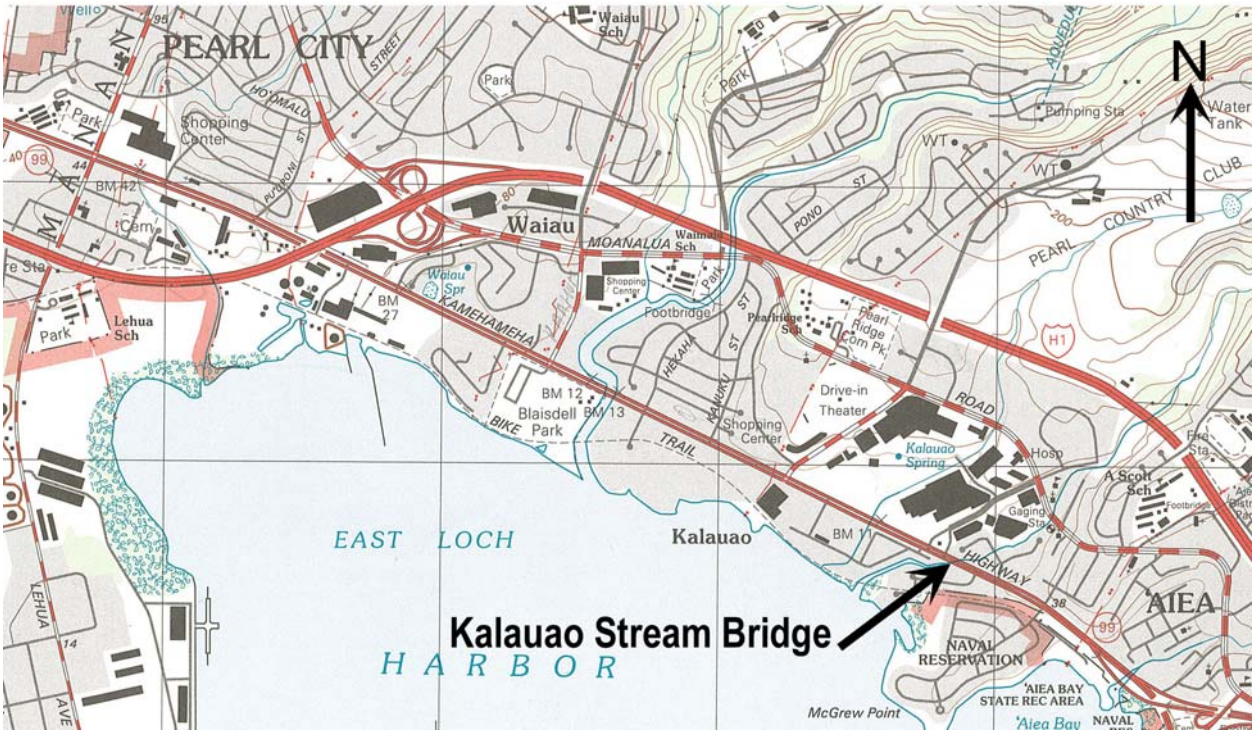
Thompson, Bethany. Historic Bridge Inventory, Island Of Oahu. Prepared for the State of Hawaii, Department of Transportation, Highways Division. June 1983.

Walker-Moody Construction Company, Ltd. "The Walker Moody Story – Company History, Start – 1940." On website at http://www.walker-moody.com/index.php/ company-history-start-1940.html, accessed on June 13, 2012.

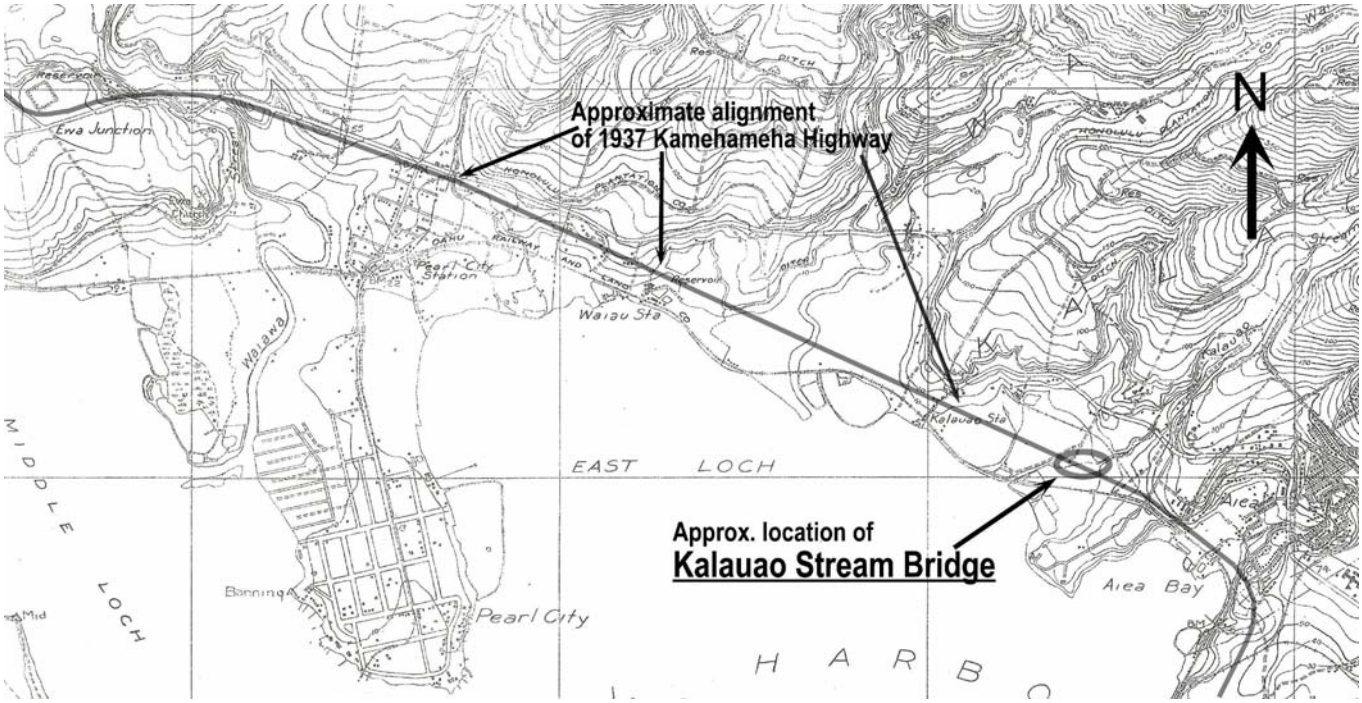
C. Likely Sources Not Yet Investigated:

National Archives and Records Administration files for the U.S. Department of Transportation, Federal Highway Administration and for predecessor agencies such as U.S. Department of Commerce, Bureau of Public Roads.

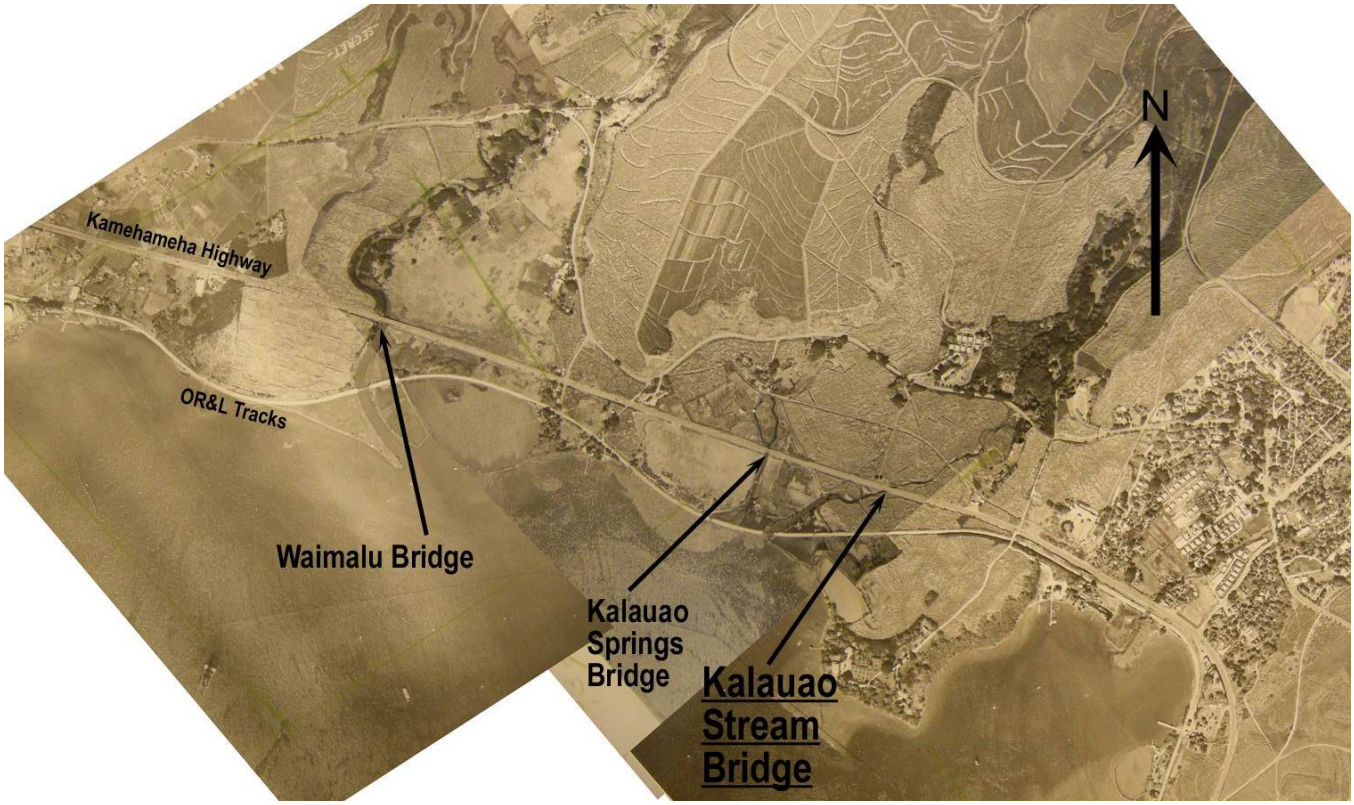
Location Map



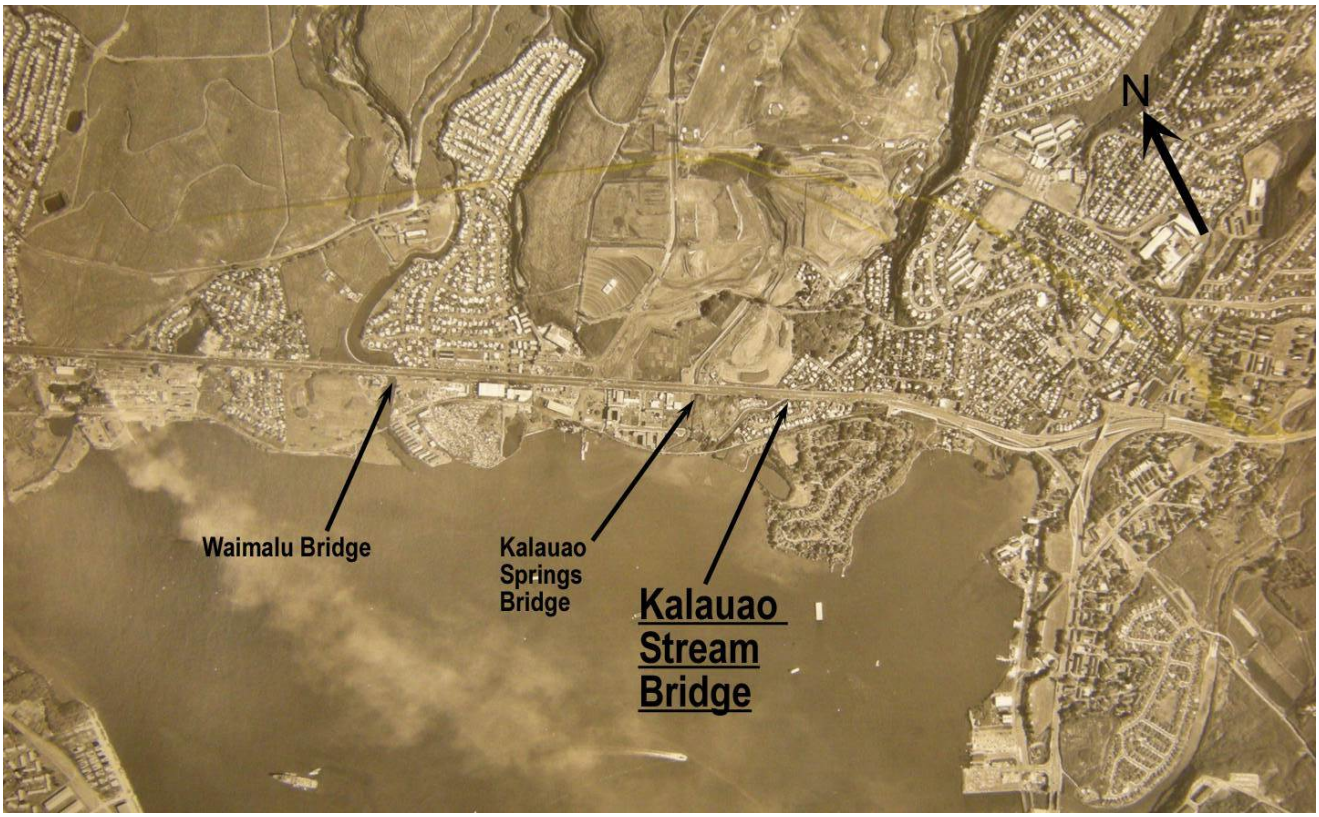
Portion of topographic map from 1927 showing the area around the (future) Kalauao Stream Bridge. The approximate alignment of Kamehameha Highway, which would be opened in 1937, has been added. *U.S. Geological Survey. Waipahu Quadrangle, 1:20,000, 1927*.



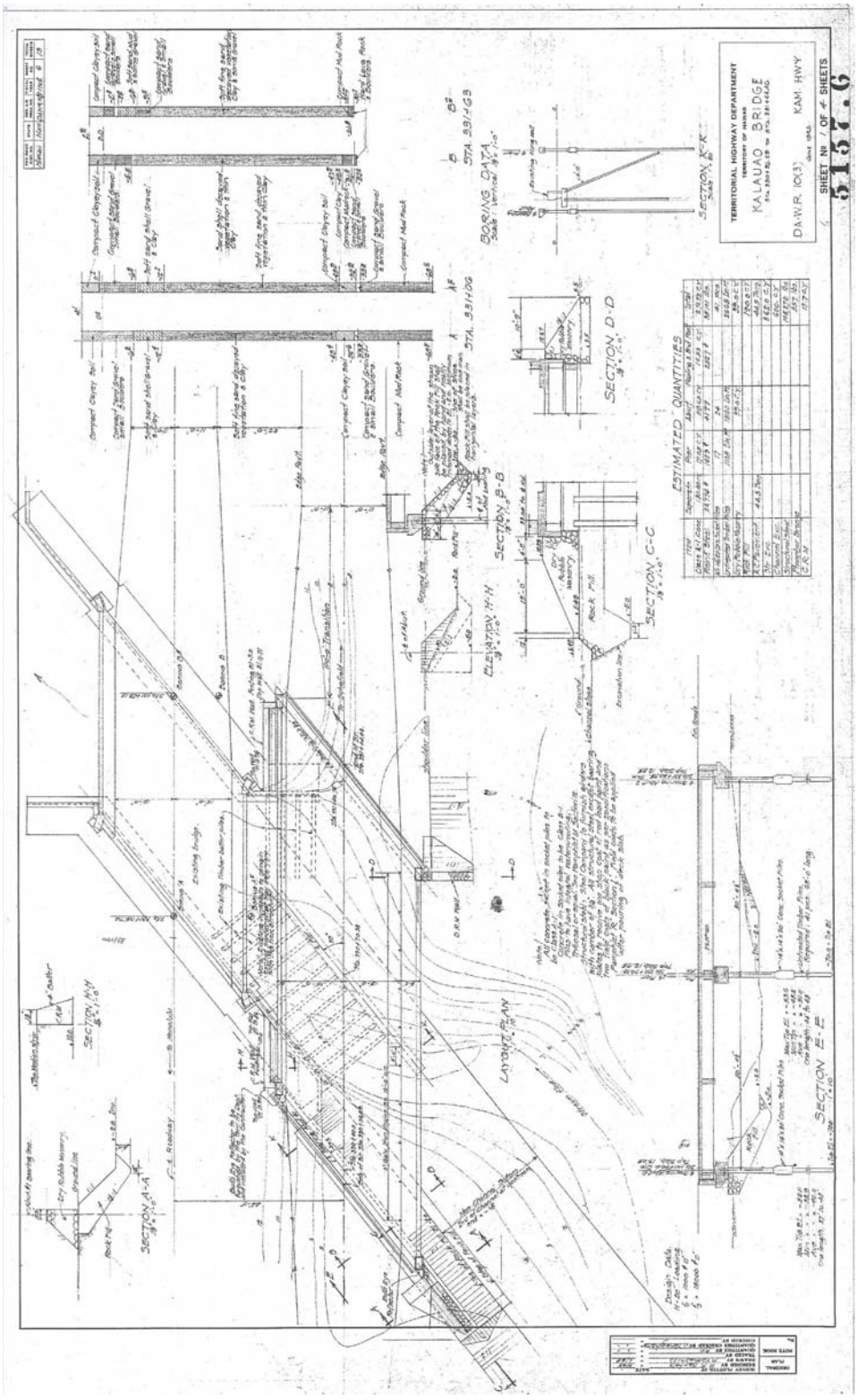
Composite of aerial photos, ca. 1940, showing the area around the Kalauao Stream Bridge (added lettering and arrows). *Hawaii State Archives, Folder PPA-59-1, photos M-58.67 & M-58.69, Folder PPA-58-5, photo M-58.37 (public domain). U.S. Army Air Corps 1939-41.*



Aerial photo dated February 6, 1968, showing the area around Kalauao Stream Bridge (added lettering and arrows). *Hawaii State Archives, Folder PPA-49-3, photo 2-14 (public domain).*



Original drawing of Kalauao Stream Bridge. *State of Hawaii, Department of Transportation, Highways Division, Design Branch, Project No. DA-WR 10 (3), Drawing 5157.6, June 1945.*



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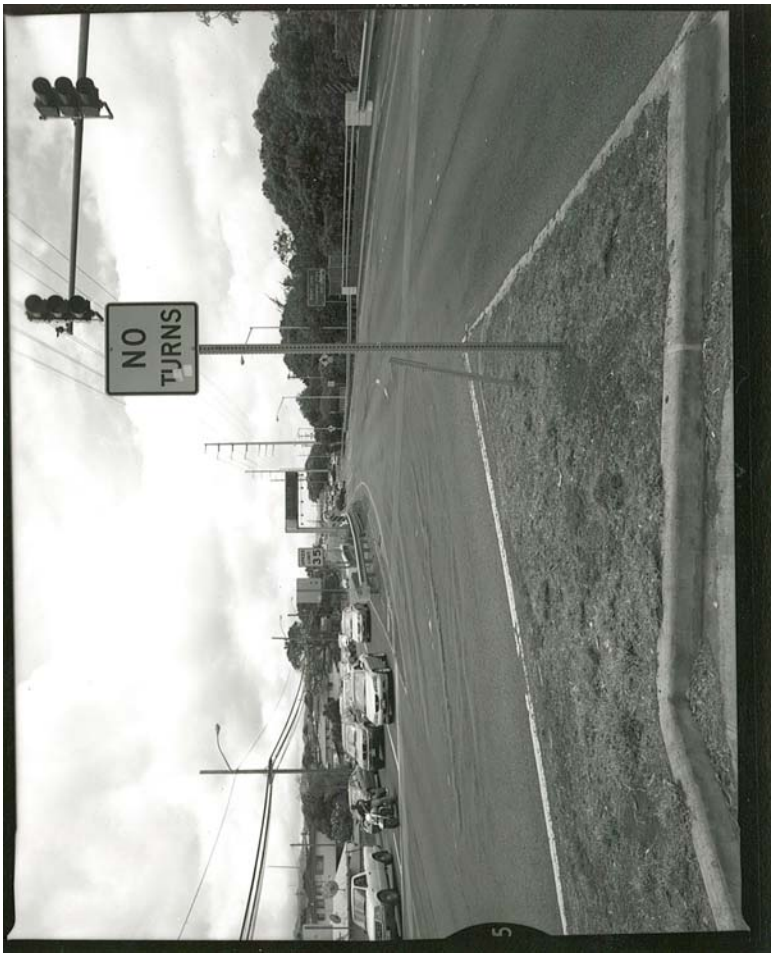

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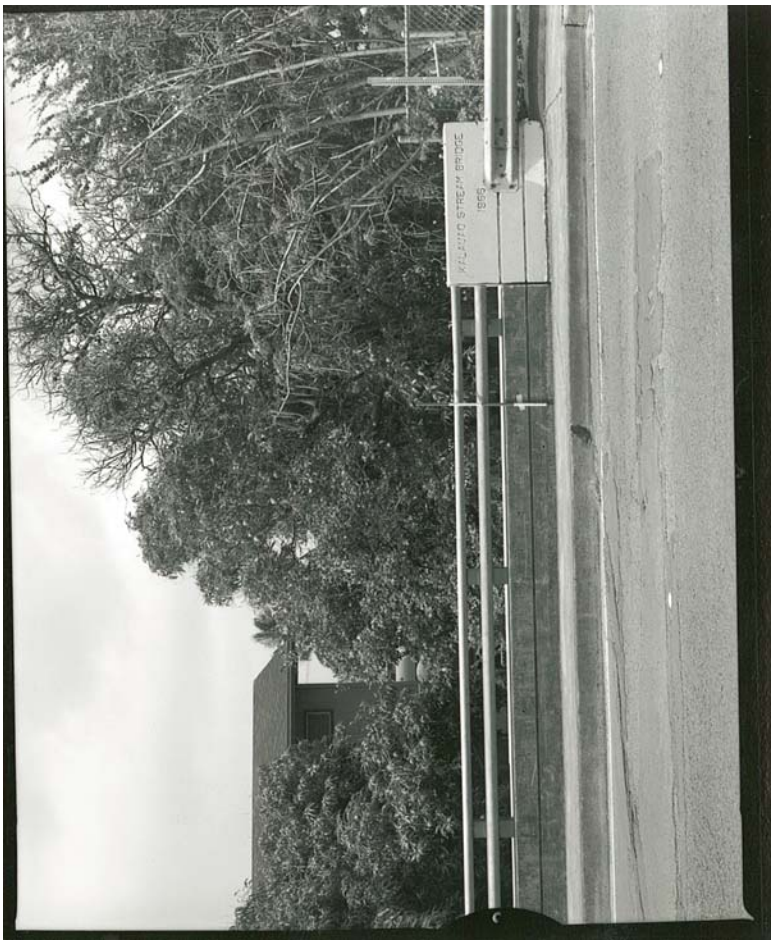

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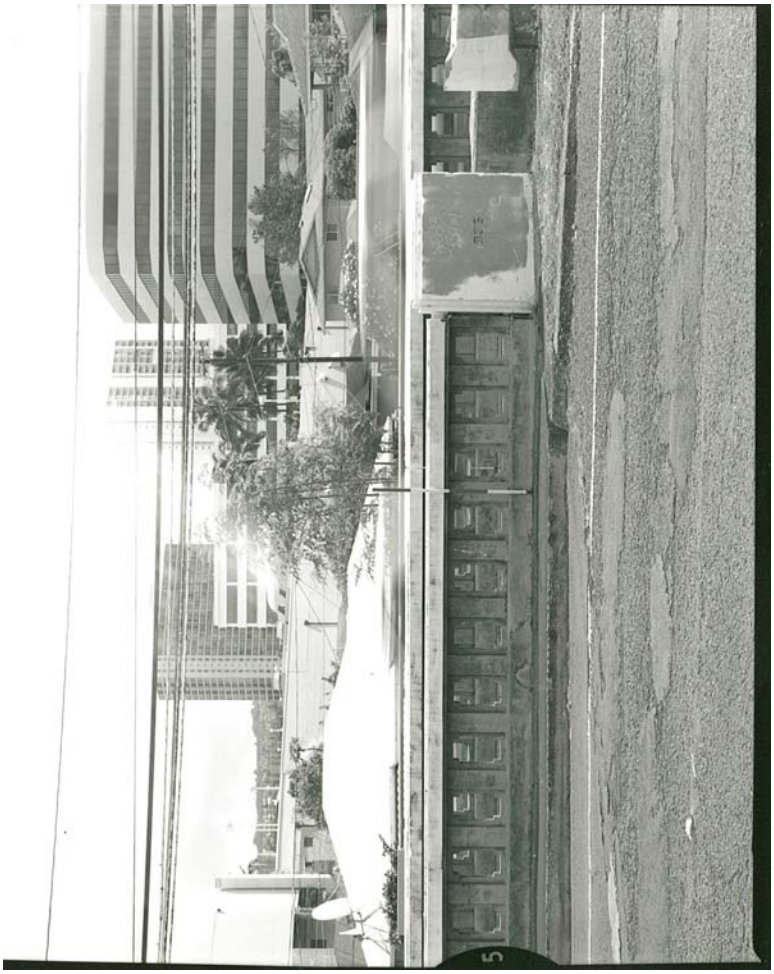

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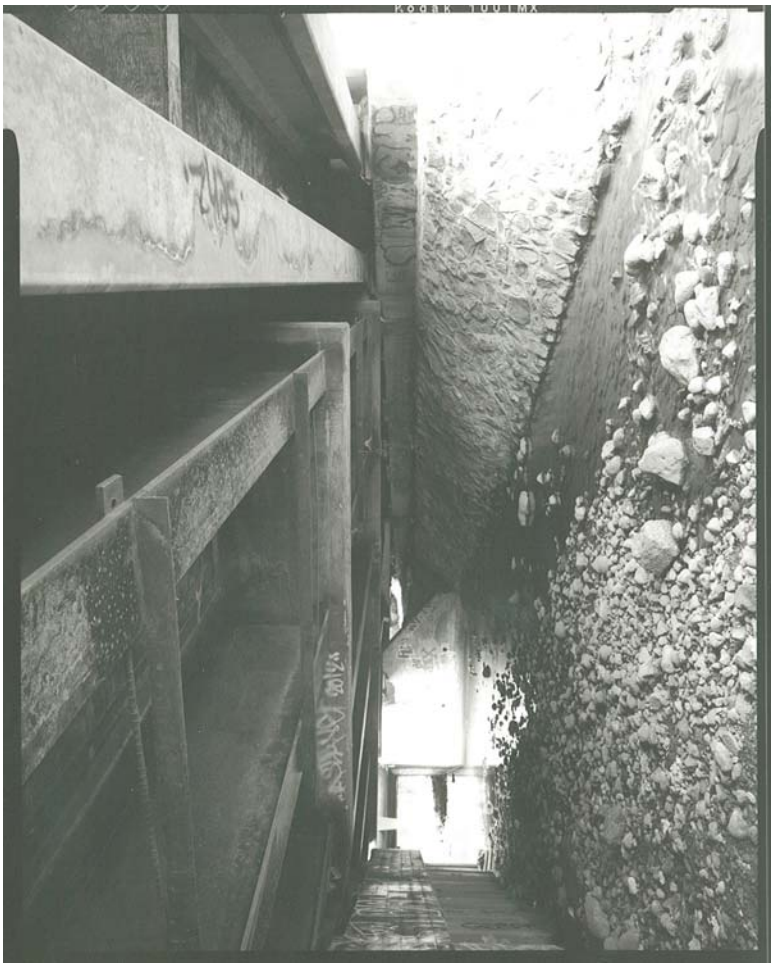

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